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GAMMA-EMISSION DATA FOR THE CALCULATION OF EXPOSURE RATES FROM NUCLEAR DEBRIS. Vol. II. Induced Activities

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ADMINISTRATIVE INFORMATION

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Commanding Officer and Director

ABSTRACT

Photon energies and photon abundances have been compiled and summarized for some induced activities which may result from nuclear events. The data are presented in tabular form, including photon energies and abundances for the gamma rays, X rays, and beta particles emitted per disintegration. A list of multipliers is also presented for converting activities of the radionuclides to infinite-plane exposure rates.

SUMMARY

The radiation exposure rate from fallout depends upon the energies and abundances of the photons emitted by the fission products and the induced activities. The latter may result from activation of device materials or of materials on the site of the detonation, including the ground, and may sometimes make a major contribution to the total exposure rate. This report presents a compilation of the photon energies and abundances for some induced activities which may be present in debris from nuclear weapons. A list of factors for converting radionuclide activities to infinite-plane exposure-rate contributions is also presented.

INTRODUCTION

In order to predict exposure rates for fallout, it is necessary to know the energies and abundances per disintegration of the gamma photons emitted by the fission products and the induced activities. In addition, the exposure per unit of photon flux, as a function of energy, must be calculated for the situation of interest. This latter result can be expressed as the average exposure at a well-defined point (in a standard situation) that results from one disintegration of a specified radionuclide. This value can be regarded as a multiplier for converting the activity of that nuclide to its contribution to the exposure rate.

Volume I of this series[1] presented gamma-photon energies and abundances for the fission products of uranium and plutonium. Appendix I of this volume presents similar data on some radionuclides which may reasonably be expected to be induced by neutron activation of materials in the vicinity of a nuclear explosion or of a reactor or of the materials of the device itself. Many of the radionuclides included in this volume have been reported to be present in fallout; the presence of others has been a matter only of speculation. Appendix II presents a list of multipliers for converting nuclide activities to exposure-rate contributions.

SOURCES AND INTERPRETATION OF PUBLISHED DECAY DATA

The Nuclear Data Sheets (NDS) published by the National Academy of Sciences-National Research Council, including additions and revisions to date, formed the basic source for this compilation. In addition, many recently published papers which have not yet been incorporated into NDS were taken into consideration.

Data on the gamma and X radiation accompanying beta decay are usually presented in the literature with a view toward establishing the energy-level structure of the nuclides involved, rather than toward displaying photon energies and abundances as such. Consequently, it is usually necessary to deduce the photon abundances by interpretation of the decay

data in conjunction with a logical decay scheme. The methods followed in assembling the data reported here are presented in detail, with illustrative examples, in Reference 1.

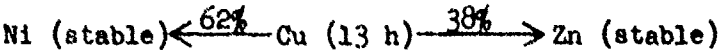
Many of the induced activities, in contrast with the fission products, decay by electron capture. This process is usually accompanied by the emission of a K- or L-series X ray. Since the K-L branching ratios are not usually well known, it was assumed for the purposes of this report that each electron capture results in the emission of a K-series X ray. This is in accord with the practice followed in Reference 1 of preferring overestimation of gamma-decay energy to underestimation, since the data are intended for use in predicting radiation hazards.

The X-ray photon abundances have not been corrected for fluorescent yield, since the contribution of the X rays to the exposure is small and the extra calculation did not seem warranted. The K-series X-ray energies have been taken from Nuclear Spectroscopy Tables.[2] For the L-series X rays, the binding energies taken from Siegbahn,[3] have been used.

BRANCHING RATIOS

In the case of branching decays, all possible decay paths were considered in calculating the photon abundances. The decay paths were considered to extend only to the next stable or metastable state. For the convenience of the user, the branching ratios used are summarized here:

Mass 64



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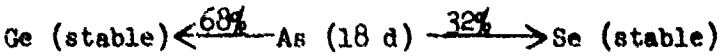
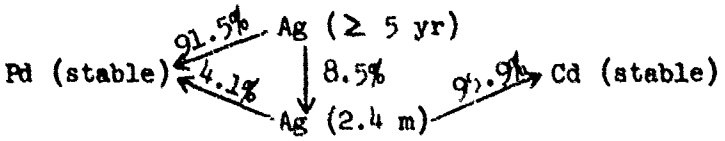


Mass 102

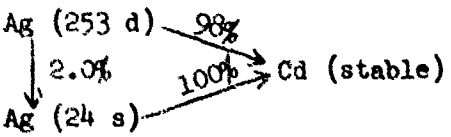
(4% of the decay not accounted for)

Mass 106

Mass 108

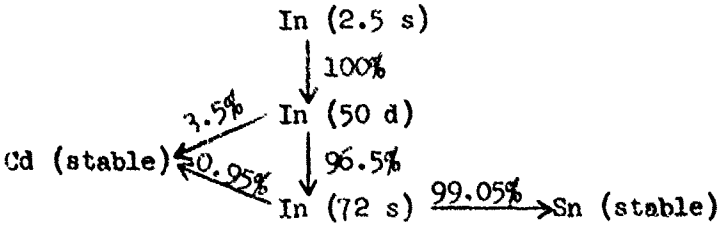


Mass 110

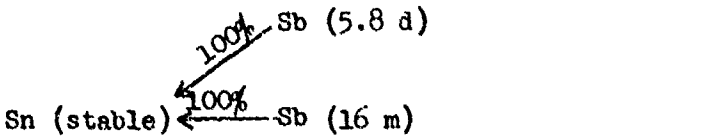


Mass 113

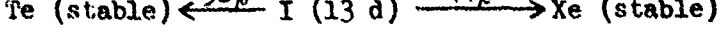
Mass 114



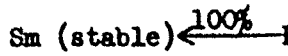
Mass 120



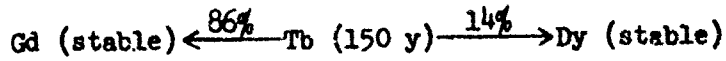
Mass 126



Mass 152

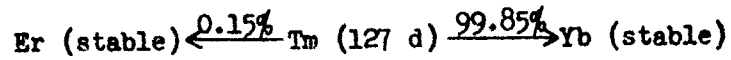


Mass 158



Mass 166

Mass 170



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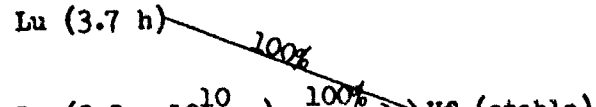
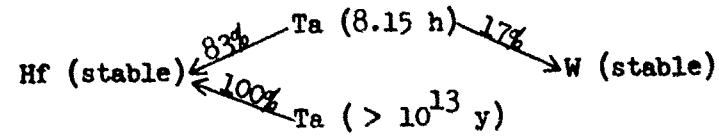
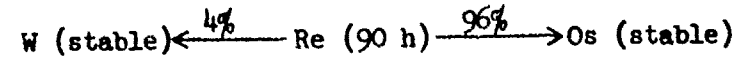


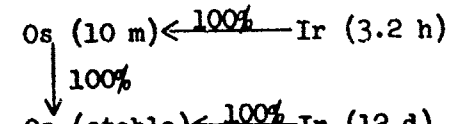
Mass 180



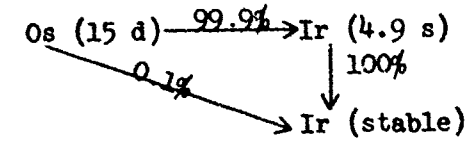
Mass 186



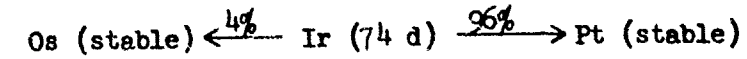
Mass 190



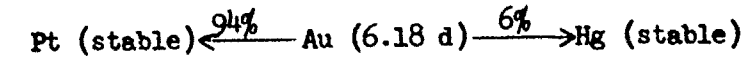
Mass 191



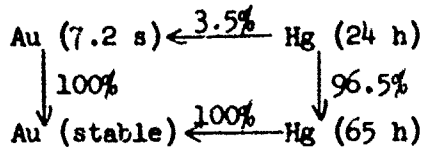
Mass 192



Mass 196



Mass 197



CALCULATION OF EXPOSURE-RATE MULTIPLIERS

The gamma-photon abundances have been used to calculate exposure-rate multipliers for converting radionuclide activities to exposure rates three feet above a uniformly contaminated, infinite plane. The multipliers are based on the build-up factors of Gates and Eisenhauer.[4] The energy conversion was made according to the following expression:

$$D = (5.97E - 1.21E^2 + 0.201E^3 - 0.013E^4) \times 10^{-6} \qquad (1)$$

where D is the exposure rate, in roentgens per hour, at a point 3 feet above an infinite plane uniformly contaminated with one emitter per square centimeter emitting one photon of energy E, in Mev, per second. If nuclide n emits N_1 photons of energy E_1 per disintegration, N_2 photons of energy E_2, etc., then a total exposure-rate multiplier, D_n, for the nuclide can be defined:

$$D_n = D_1N_1 + D_2N_2 + \ldots.$$

If the activity per square centimeter, A_n, of the nuclide is known, the contribution of the nuclide to the exposure rate is D_nA_n roentgens per hour.

The exposure-rate multipliers for the induced activities are listed in Appendix II. Since the multipliers were hand-calculated, the energy-to-exposure-rate conversion factors were read from a graph of equation 1. Those multipliers marked with an asterisk pertain to nuclides which do not emit photons with energies greater than 0.075 Mev. Calculations for such low energies are very uncertain.

REFERENCES

1. G. R. Crocker, M. A. Connors, "Gamma-Emission Data for the Calculation of Exposure Rates From Nuclear Debris, Vol. I. Fission Products," U. S. Naval Radiological Defense Laboratory, USNRDL-TR-876, 28 July 1965.

2. A. H. Wapstra, G. J. Nijgh, R. van Lieshout. Nuclear Spectroscopy Tables. New York, Interscience Publishers, Inc., 1959.

3. K. Siegbahn. Beta- and Gamma-Ray Spectroscopy. New York, Interscience Publishers, Inc., 1955.

4. L. D. Gates, Jr., C. Eisenhauer, "Spectral Distribution of Gamma Rays Propagated in Air," Armed Forces Special Weapons Project, Technical Analysis Report AFSWP No. 502A, 1954.

APPENDIX I

SUMMARY OF PHOTON ENERGIES AND ABUNDANCES

Nuclides are arranged by ascending atomic numbers, ordered by mass number. Metastable-state decays are summarized separately. The half-life of each nuclide is stated below its identification. The source or sources of the data are quoted at the beginning of each summary. The abbreviation NDS is used for the Nuclear Data Sheets compiled and published by the National Academy of Sciences-National Research Council. Other literature abbreviations follow standard practice.

The data contained in the columns is indicated by the headings, as follows:

- E_γ - Gamma energy in Mev.
- N_T - Number of transitions per disintegration. This column is totalled. This column was for the compiler's convenience and was frequently omitted.
- N_γ - Number of gamma photons emitted per disintegration. This column is totalled.
- N_K - Number of gammas converted to X-ray photons per disintegration. This column is totalled.
- $N_\gamma E_\gamma$ - Product of abundance and energy. This column is totalled.
- E_β - End-point beta-ray energy in Mev.
- N_β - Corresponding number of beta particles per disintegration.

Following the columns the X-ray energy, E_K, is given. The product of this energy times the total of the N_K column is given. The following totals are then listed:

- PH - Total photons emitted per disintegration.
- HPH - Total photons emitted per disintegration with energies greater than 0.020 Mev.
- ED - Total photon energy per disintegration (Mev/D).
- HED - Total photon energy per disintegration (Mev/D) counting only photons greater than 0.020 Mev.

Source: J. G. V. Taylor and J. S. Merritt, Can. J. Phys. 40, 926 (1962).

4 Be 7
53.4 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.477	0.115	- - -	0.055	Decays by E. C.	
capture e^-	- - -	1.0	- - -		

$E_K = 5 \times 10^{-5}$ Mev $E_K N_K \sim 0$

PH = 0.115 ED = 0.055 Mev/D

HPH = 0.115 HED = 0.055 Mev/D

Source: NDS 59-4-16 and 59-4-19

11 Na 22
2.6 years

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.274	1.0	- - -	1.274	0.544	0.898
capture e^-	- - -	0.102	- - -		

$E_K = 0.00087$ Mev $E_K N_K \sim 0$

PH = 1.102 ED = 1.274 Mev/D

HPH = 1.0 HED = 1.274 Mev/D

Source: NDS 59-6-10a and 59-6-13

11 Na 24
15.0 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.368	1.0	- - -	1.368	0.391	1.0
2.750	1.0	- - -	2.750		
Total	2.0		4.118		

$E_K = 0.0013$ Mev $N_K E_K = 0$

PH = 2.0 ED = 4.118 Mev/D

HPH = 2.0 HED = 4.118 Mev/D

Source: NDS 59-6-27 and 59-6-34

13 Al 26
7.4×10^5 years

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
2.97	0.003	0.003	- - -	0.009	1.16	0.96
1.14	0.037	0.037	- - -	0.042		
1.83	0.997	0.997	- - -	1.825		
capture e^-	- - -	- - -	0.052	- - -		
Total	1.037	1.037	0.052	1.876		

E_K = 0.0013 Mev
PH = 1.089
HPH = 1.037

$N_K E_K$ = 0.0001
ED = 1.876 Mev/D
HED = 1.876 Mev/D

Source: NDS 60-3-25 and 60-3-27

14 Si 31
2.6 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.27	0.0007	- - -	0.001	0.210	0.0007
				1.477	0.9993

PH = 0.0007
HPH = 0.0007

ED = 0.001 Mev/D
HED = 0.001 Mev/D

Source: NDS 60-1-53 and 60-1-57

17 Cl 34m
32.4 min.

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.16	0.166	- - -	0.193	0.43	0.003
2.13	0.353	- - -	0.752	1.24	0.322
3.30	0.166	- -	0.548	2.41	0.351
4.10	0.006	- - -	0.025		
capture e^-	- - -	0.015	- - -		
Total	0.691	0.015	1.518		

E_K = 0.0025 Mev
PH = 0.706
HPH = 0.691

$N_K E_K$ = 0
ED = 1.518 Mev/D
HED = 1.518 Mev/D

Source: NDS 60-1-60 and 60-1-63

17 Cl 38
38 min.

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.60	0.31	- - -	0.496	1.11	0.31
2.16	0.47	- - -	1.015	2.77	0.16
				4.81	0.53
Total	0.78		1.511		

PH = 0.78
HPH = 0.78

ED = 1.511 Mev/D
HED = 1.511 Mev/D

Source: D. W. Engelkemeir, K. F. Flynn and L. E. Glendenin, Phy. Rev. 126, 1818 (1962).

19 K 40
1.27×10^9 year

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.46	0.11	- - -	0.161	1.321	0.89
capture e^-	- - -	0.11	- - -		

E_K = 0.0032 Mev

$N_K E_K$ = 0.0004

PH = 0.11
HPH = 0.11

ED = 0.161 Mev/D
HED = 0.161 Mev/D

Source: NDS 60-6-3

19 K 42
12.5 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.92	0.0006	- - -	0.0010	0.09	0.0008
1.02	0.0002	- - -	0.0002	0.28	0.0002
0.49	0.0002	- - -	- - -	1.11	0.0006
2.44	0.0004	- - -	0.0010	1.71	0.0018
0.90	0.0002	- - -	0.0002	2.03	0.1770
0.60	0.0002	- - -	0.0001	3.55	0.8200
0.32	0.0020	- - -	0.0006		
1.52	0.1800	- - -	0.2736		
Total	0.1838		0.2767		

PH = 0.1838
HPH = 0.1838

ED = 0.2767 Mev/D
HED = 0.2767 Mev/D

Source: NDS 60-2-16 and 60-2-20

21 Sc 44m
2.4 days

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.27	1.0	0.877	0.123	0.2368	Isomeric Transition*	

E_K = 0.0041 Mev
PH = 1.0
HPH = 0.877

$N_K E_K$ = 0.0005
ED = 0.2373 Mev/D
HED = 0.2368 Mev/D

*There is actually some small unknown amount of E. C. directly to Ca^{44} (L. T. Dillman and J. J. Kraushaar, Nucl. Phys., 42, 383, 1963), but this has been ignored. This schema is for: Sc^{44m} 100% $\rightarrow$ Sc^{44} 100% $\rightarrow$ Ca^{44}

Source: NDS 60-2-16 and 60-2-20

21 Sc 44
3.9 hours

E_γ Mev	N_T	N_γ**	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
2.69	0.002	0.002	- - -	0.005	1.467	0.91
1.50	0.010	0.010	- - -	0.015		
2.28	0.002	0.002	- - -	0.005		
1.14	0.030	0.030	- - -	0.034		
1.16	1.000	1.000	- - -	1.160		
capture e^-	- - -	- - -	0.085	- - -		
Total	1.044	1.044	0.085	1.219		

E_K = 0.0037 Mev
PH = 1.129
HPH = 1.044

$N_K E_K$ = 0.0003
ED = 1.219 Mev/D
HED = 1.219 Mev/D

**Gamma intensities agree reasonably well with L. T. Dillman and J. J. Kraushaar, Nucl. Phys., 42, 383, 1963.

Source: NDS 60-2-30 and 60-2-34

21 Sc 46m
20 sec.

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.15	1.0	0.5	0.5	0.075	Isomeric Transition	

E_K = 0.0041 Mev
PH = 1.0
HPH = 0.5

$N_K E_K$ = 0.0021
ED = 0.077 Mev/D
HED = 0.075 Mev/D

Source: NDS 60-2-30 and 60-2-33

21 Sc 46
84 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.119	1.0	- - -	1.119	0.357	1.0
0.887	1.0	- - -	0.887		
Total	2.0		2.006		

(There is probably a crossover transition of ~ 2 Mev of very low intensity. See Ark. Fys. 21, 383, 1962)

PH = 2.0 ED = 2.006 Mev/D
HPH = 2.0 HED = 2.006 Mev/D

Source: NDS 60-2-23 and 60-2-28

22 Ti 45
3.1 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.376	0.003	- - -	0.001	0.62	0.003
				1.02	0.850
capture e^-	- - -	0.15	- - -		

E_K = 0.0041 Mev $N_K E_K$ = 0.0006
PH = 0.153 ED = 0.0016 Mev/D
HPH = 0.003 HED = 0.001 Mev/D

Source NDS 61-3-3

23 V 49
330 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
capture e^-	- - -	1.0	- - -	Decays by E. C.	

E_K = 0.0046 Mev $N_K E_K$ = 0.0046
PH = 1.0 ED = 0.0046 Mev/D
HPH = 0 HED = 0 Mev/D

Source: NDS 61-3-3 and 61-3-11

24 Cr 49
42 min.

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.063	0.130	0.018	0.0082	1.39	0.266
0.089	0.277	0.018	0.0247	1.46	0.139
0.150	0.139	0.003	0.0209	1.54	0.527
capture e^-	- - -	0.068	- - -		
Total	0.546	0.107	0.0538		

E_K = 0.0046 Mev $N_K E_K$ = 0.0005
PH = 0.653 ED = 0.0543 Mev/D
HPH = 0.546 HED = 0.0538 Mev/D

Source: NDS 61-3-14 and 61-3-20

24 Cr 51
28 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.645	0.0005	- - -	0.0003	Decays by E. C.	
0.320	0.0010	- - -	0.0003		
0.322	0.0910	- - -	0.0293		
capture e^-	- - -	1.0	- - -		
Total	0.0925	1.0	0.0299		

E_K = 0.0046 Mev $N_K E_K$ = 0.0046
PH = 1.0925 ED = 0.0345 Mev/D
HPH = 0.0925 HED = 0.0299 Mev/D

Source: P. Kramer, Miss E. C. Bos, A. deBeer and J. Blok, Physica 28, 569 (1962). C. Manduche and G. Zannoni, Nuovo Cimento 27, 251 (1963).

25 Mn 54
291 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.842	1.0	- - -	0.842	Decays by E. C.	
capture e^-	- - -	0.902	- - -		

E_K = 0.0055 Mev $N_K E_K$ = 0.0050
PH = 1.902 ED = 0.847 Mev/D
HPH = 1.0 HED = 0.842 Mev/D

Source: NDS 59-4-50. D. A. Howe, L. M. Langer, E. H. Spejweski and D. E. Wortman, Phys. Rev. 128, 2748 (1962).

25 Mn 56
2.58 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.845	1.000	- - -	0.845	0.300	0.01
1.810	0.333	- - -	0.603	0.718	0.18
2.120	0.175	- - -	0.371	1.028	0.34
2.520	0.009	- - -	0.023	2.838	0.47
2.660	0.007	- - -	0.019		
2.960	0.005	- - -	0.015		
3.390	0.002	- - -	0.007		
Total	1.531		1.883		

E_K = 0.0065 Mev
PH = 1.531
HPH = 1.531

$N_K E_K \approx 0$
ED = 1.883 Mev/D
HED = 1.883 Mev/D

Source: NDS 59-2-3 and 59-2-9

26 Fe 55
2.7 years

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
capture e^-	- - -	1.0	- - -	Decays by E. C.	

E_K = 0.0065 Mev
PH = 1.0
HPH = 0

ED = 0.0065 Mev/D
HED = 0 Mev/D

Source: NDS 60-6020

26 Fe 59
45 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.337	0.003	- - -	0.0010	0.130	0.010
0.145	0.008	- - -	0.0012	0.271	0.460
1.290	0.440	- - -	0.5676	0.462	0.540
0.191	0.030	- - -	0.0057	1.560	0.003
1.100	0.570	- - -	0.6270		
Total	1.051		1.2025		

PH = 1.051
HPH = 1.051

ED = 1.203 Mev/D
HED = 1.203 Mev/D

Source: NDS 61-2-13 and 61-2-21. P. Kramer, et al, Physica 28, 569 (1962).

27 Co 57
270 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.014	0.120	0.780	0.0017	Decays by E. C.	
0.122	0.890	0.010	0.1086		
0.136	0.088	0.012	0.0120		
0.710	0.002	- - -	0.0014		
capture e^-	- - -	0.870	- - -		
Total	1.100	1.672	0.1237		

E_K = 0.0065 Mev
$N_K E_K$ = 0.0109
PH = 2.772
ED = 0.1346 Mev/D
HPH = 1.100
HED = 0.1237 Mev/D

Source: NDS 60-5-12 and 60-5-18

27 Co 58m
9.0 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.025	1.0	- - -	0.025	Isomeric Transition	

PH = 1.0
ED = 0.025 Mev/D
HPH = 1.0
HED = 0.025 Mev/D

Source: NDS 60-5-12 and 60-2-17

27 Co 58
71 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.650	0.005	- - -	0.0083	0.485	0.148
0.810	0.016	- - -	0.0130		
0.805	0.995	- - -	0.8010		
capture e^-	- - -	0.852	- - -		
Total	1.016	0.852	0.8223		

E_K = 0.0065 Mev
$N_K E_K$ = 0.0055
PH = 1.868
ED = 0.8278 Mev/D
HPH = 1.016
HED = 0.8223 Mev/D

Source: NDS 60-5-24 and 60-5-27

27 Co 60
5.27 years

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.173	1.0	- - -	1.173	0.318	1.0
1.332	1.0	- - -	1.332		
Total	2.0		2.505		

PH = 1.0
HPH = 1.0
ED = 2.505 Mev/D
HED = 2.505 Mev/D

Source: G. Chilosi, S. Monaro and R. A. Ricci,

28 Ni 57
36.5 hours

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.360	0.750	0.750	- - -	1.020	0.32	0.006
0.130	0.130	0.130	- - -	0.017	0.47	0.011
1.590	0.012	0.012	- - -	0.019	0.63	0.003
1.750	0.075	0.075	- - -	0.131	0.73	0.043
1.910	0.160	0.160	- - -	0.306	0.86	0.310
capture e^-	- - -	- - -	0.624	- - -		
Total	1.127	1.127	0.624	1.493		

E_K = 0.0070 Mev
PH = 1.751
HPH = 1.127
$N_K E_K$ = 0.0044
ED = 1.497 Mev/D
HED = 1.493 Mev/D

Source: R. A. Ricci et al., Nuovo Cimento 17, 523 (1960).
R. Jambunathan et al., Phys. Rev. 120, 1839 (1960).

28 Ni 65
2.5 hours

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.730	0.006	0.006	- - -	0.0104	0.375	0.004
1.630	0.011	0.011	- - -	0.0179	0.477	0.004
1.490	0.280	0.280	- - -	0.4172	0.618	0.220
0.360	0.060	0.060	- - -	0.0216	0.986	0.079
1.120	0.130	0.130	- - -	0.1456	2.100	0.690
Total	0.487	0.487		0.6127		

PH = 0.487
HPH = 0.487
ED = 0.6127 Mev/D
HED = 0.6127 Mev/D

Source: NDS 59-2-13 and 59-2-16

29 Cu 64
13 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.34	0.006	- - -	0.008	0.573	0.38
- - -	- - -	- - -	- - -	0.656	0.19
capture e^-	- - -	0.43	- - -		

E_K = 0.0076 Mev
PH = 0.436
HPH = 0.006

$N_K E_K$ = 0.0033
ED = 0.011 Mev/D
HED = 0.008 Mev/D

Source: J. B. Cumming and N. T. Porile, Phy. Rev. 122, 1267 (1961).

30 Zn 63
38.4 min.

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.67	0.074	0.074	- - -	0.050	2.33	0.800
0.96	0.051	0.051	- - -	0.049	1.66	0.074
- - -	- - -	- - -	- - -	- - -	1.37	0.051
Few other weak γ's		(<0.010)	- - -	- - -	3 others	<0.01
capture e^-	- - -	- - -	0.059	- - -		
Total	1.125	0.125	0.059	0.099		

E_K = 0.0082 Mev
PH = 0.184
HPH = 0.125

$N_K E_K$ = 0.0005
ED = 0.0995 Mev/D
HED = 0.099 Mev/D

Source: NDS 59-2-23 and 59-2-26

30 Zn 65
245 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.114	0.49	- - -	0.546	0.326	0.017
capture e^-	- - -	0.983	- - -		

E_K = 0.0082 Mev
$N_K E_K$ = 0.008
PH = 1.473
HD = 0.554 Mev/D
HPH = 0.49
HED = 0.546 Mev/D

Source: NDS 59-3-30 and 59-3-32

30 Zn 69m
14 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.435	0.943	0.057	0.410	Isomeric Transition	

E_K = 0.0087
PH = 1.000
HPH = 0.943

$N_K E_K$ = 0.0005
ED = 0.4105 Mev/D
HED = 0.4100 Mev/D

Source: NDS 59-2-39 and 59-2-41
T. T. Thwaites and W. W. Pratt, Phys. Rev. 124, 1526 (1961).

30 Zn 71m
4 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.38	1.0	- - -	0.38	1.5	1.0
0.49	1.0	- - -	0.49		
0.61	1.0	- - -	0.61		
Total	3.0		1.48		

PH = 3.0
HPH = 3.0

ED = 1.48 Mev/D
HED = 1.48 Mev/D

Source: T. T. Thwaites and W. W. Pratt
Phys. Rev 124, 1526 (1961).

30 Zn 71
2.45 min

E_γ (Mev)	N_γ	N_K	$N_\gamma E_\gamma$	E_β (Mev)	N_β
1.63	0.001	- -	0.0016	0.99	0.017
1.12	0.013	- -	0.0146	1.69	0.030
0.68	0.003	- -	0.0020	2.10	0.140
0.92	0.031	- -	0.0285	2.61	0.820
0.12	0.009	- -	0.0011		
0.39	0.013	- -	0.0051		
0.51	0.140	-	0.0714		
Total	0.210		0.1243		

PH = 0.210
HPH = 0.210

ED = 0.1243 Mev/D
HED = 0.1243 Mev/D

Source: A. W. Schardt and A. Goodman, Phys. Rev. 123, 893 (1961) 33 As ^{74m} 8 sec.

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.283	1.0	- - -	0.283	Isomeric Transition	

PH = 1.0
HPH = 1.0

ED = 0.283 Mev/D
HED = 0.283 Mev/D

Source: NDS 59-4-67 and 59-4-71

33 As 74
18 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.5963	0.608	- - -	0.363	0.72	0.145
0.6350	0.145	- - -	0.921	1.36	0.177
- - -	- - -	- - -	- - -	0.91	0.261
- - -	- - -	- - -	- - -	1.51	0.036
capture e^-	- - -	0.381	- - -		
Total	0.753	0.381	0.4559		

Several very weak γ's ignored.

E_K = 0.010 Mev
PH = 1.134
HPH = 7.53

$N_K E_K$ = 0.0038
ED = 0.4597 Mev/D
HED = 0.4559 Mev/D

Source: NDS 60-3-67 and 60-3-73

39 Y 88
105 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
2.760	0.005	- - -	0.0138	0.57	0.007
0.899	0.920	- - -	0.8271		
1.835	1.000	- - -	1.8350		
capture e^-	- - -	0.993	- - -		
Total	1.925	0.993	2.6759		

E_K = 0.0144 Mev
PH = 2.918
HPH = 1.925

$N_K E_K$ = 0.0143
ED = 2.6902 Mev/D
HED = 2.6759 Mev/D

Source: NDS 61-2-37. P. Born, C. Bobeldijk, H. M. W. Booy and J. Blok, Physica 27, 1229 (1961)

45 Rh 102
206 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.417	0.020	- - -	0.0083	1.15	0.186
0.475	0.545	- - -	0.2589	0.81	0.039
0.630	0.110	- - -	0.0693	1.28	0.102
0.695	0.064	- - -	0.0445		
0.745	0.005	- - -	0.0037		
0.765	0.047	- - -	0.0360		
1.050	0.063	- - -	0.0662		
1.110	0.027	- - -	0.0300		
1.105	0.028	- - -	0.0309		
1.365	0.004	- - -	0.0055		
1.565	0.002	- - -	0.0031		
capture e^-	- ---	0.585	- - -		
Total	0.915	0.585	0.5564		

E_K = 0.0196 $N_K E_K$ = 0.0115
PH = 1.500 ED = 0.5679 Mev/D
HPH = 0.915 HED = 0.5564 Mev/D

Source: NDS 60-4-44 and 60-4-52

47 Ag 106m
8.3 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
1.20	0.09	- - -	0.108
0.81	0.11	- - -	0.089
0.72	0.23	- - -	0.166
0.46	0.22	- - -	0.101
0.41	0.30	- - -	0.123
1.83	0.03	- - -	0.055
1.23	0.09	- - -	0.111
0.78	0.12	- - -	0.094
0.41	0.05	- - -	0.021
0.74	0.13	- - -	0.096
0.21	0.09	- - -	0.019
1.58	0.09	- - -	0.142
1.54	0.15	- - -	0.231
0.70	0.08	- - -	0.056
0.31	0.01	- - -	0.003
0.82	0.17	- - -	0.139
0.75	0.05	- - -	0.038
1.73	0.016	- - -	0.028
1.56	0.01	- - -	0.016
1.05	0.31	- - -	0.326
0.85	0.08	- - -	0.068
1.12	0.11	- - -	0.123
0.612	0.23	- - -	0.141
0.513	0.86	- - -	0.441
capture e^-	- - -	1.0	- - -
Total	3.63	1.0	2.735

E_β Mev	N_β
Decays by E. C.	

E_K = 0.0216 Mev

$E_K N_K$ = 0.0216

PH = 4.63

ED = 2.757 Mev/D

HPH = 4.63

HED = 2.757 Mev/D

Source: NDS 60-4-44 and 60-4-52

47 Ag 106
24 min.

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.513	1.0	1.0	- - -	0.513	1.45	0.07
- - -	- - -	- - -	- - -	- - -	1.96	0.5[b]
capture e^-	- - -	- - -	0.39	- - -		

E_K = 0.0216 Mev
PH = 1.39
HPH = 1.39

$N_K E_K$ = 0.008 Mev/D
ED = 0.521 Mev/D
HED = 0.521 Mev/D

Source: NDS 60-5-135 and 60-5-141

47 Ag 107m
44 sec.

E_γ (Mev)	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.094	0.095	0.905	0.0089	Isomeric Transition	

E_K = 0.0226 Mev $N_K E_K$ = 0.0205
PH = 1.00 ED = 0.0294 Mev/D
HPH = 1.00 HED = 0.0294 Mev/D

Source: NDS 5-1-5 and 5-1-10

47 Ag 108m
>5 years

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.724	1.000	- - -	0.724	Isomeric Transition	
0.618	1.000	- - -	0.618	and E. C.	
0.433	1.000	- - -	0.433		
0.031	0.085	- - -	0.003		
0.081	0.067	0.018(Ag)	0.005		
capture e^-	- - -	0.915(Pd)	- - -		
Total	3.152	0.933	1.783		

E_K(Ag) = 0.0226 Mev $N_K E_K$ = 0.0004 Mev/D

E_K(Pd) = 0.0216 Mev $N_K E_K$ = 0.0198 Mev/D

PH = 4.085 ED = 1.803 Mev/D

HPH = 4.085 HED = 1.803 Mev/D

Source: NDS 5-1-5 and 5-1-9

47 Ag 108
2.4 min.

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.633	0.019	- - -	0.012	1.02	0.019
0.617	0.004	- - -	0.002	1.65	0.940
0.433	0.006	- - -	0.003	0.69	0.002
capture e^-	- - -	0.033	- - -		
Total	0.029	0.033	0.017		

E_K = 0.0216
PH = 0.062
HPH = 0.062

$N_K E_K$ = 0.0007
ED = 0.0177 Mev/D
HED = 0.0177 Mev/D

Source: NDS 60-2-47

47 Ag 109m
39.00 sec.

E_γ (Mev)	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.088	0.046	0.436	0.004	Isomeric Transition	

E_K = 0.023 Mev
PH = 0.482
HPH = 0.482

$N_K E_K$ = 0.010
ED = 0.014 Mev/D
HED = 0.014 Mev/D

Source: NDS 60-2-62 and -66 and -67

47 Ag 110m
253d

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.116	0.02	- -	0.02	- -	0.085	0.65
0.030	0.02	- -	0.02	- -	0.530	0.33
1.384	0.24	0.24	- -	.3322		
0.764	0.23	0.23	- -	.1757		
0.706	0.19	0.19	- -	.1341		
0.446	0.06	0.06	- -	.0268		
0.937	0.34	0.34	- -	.3186		
1.56	0.01	0.01	- -	.0156		
0.745	0.02	0.02	- -	.0149		
0.677	0.09	0.09	- -	.0609		
1.504	0.12	0.12	- -	.1805		
0.687	0.07	0.07	- -	.0481		
0.619	0.04	0.04	- -	.0248		
0.885	0.72	0.72	- -	.6372		
1.474	0.05	0.05	- -	.0737		
0.815	0.07	0.07	- -	.0571		
0.656	0.93	0.93	- -	.6101		
Total	3.22	3.18	0.04	2.7103		

E_K = 0.0226 Mev
PH = 3.22
HPH = 3.22

$E_K N_K$ = 0.0009 Mev/D
ED = 2.7112 Mev/D
HED = 2.7112 Mev/D

Source: NDS 60-2-62 and 60-2-63

47 Ag 110
24 sec.

E_γ (Mev)	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.656	0.05	- -	0.0328	2.21	0.05
				2.87	0.95

PH = 0.05
HPH = 0.05

ED = 0.0328 Mev/D
HED = 0.0328 Mev/D

Source: NDS 60-5-135 and 60-5-143. N. L. Lark et al., Nucl. Phys. 35, 582, (1962).

48 Cd 107
6.5 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.846	0.002	- - -	0.002	0.32	0.003
0.094	0.513	0.224	0.048		
capture e^-	- - -	0.997	- - -		
Total	0.515	1.221	0.050		

E_K = 0.0226 Mev $N_K E_K$ = 0.028

PH = 1.736 ED = 0.078 Mev/D

HPH = 1.736 HED = 0.078 Mev/D

Source: NDS 60-2-48 and 60-2-56

48 Cd 109
470 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
capture e^-	- - -	1.0	- - -	Decays by E. C.	

E_K = 0.0226 Mev
PH = 1.0
HPH = 1.0

$N_K E_K$ = 0.0226
ED = 0.0226 Mev/D
HED = 0.0226 Mev/D

Source: NDS 60-2-99 and 60-2-103

48 Cd 113m
14 years

E_γ (Mev)	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.265	0.001	- -	0.0003	0.575	0.999

PH = 0.001
HPH = 0.001

ED = 0.0003 Mev/D
HED = 0.0003 Mev/D

Source: NDS 60-2-99 and 60-2-105

49 In 113m
1.7 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.393	0.667	0.333	0.2621	Isomeric Transition	

E_K = 0.0247 Mev
PH = 1.0
HPH = 1.0

$N_K E_K$ = 0.0082
ED = 0.270 Mev/D
HED = 0.270 Mev/D

Source: NDS 60-3-88 and 60-3-98

49 In $114m_2$
2.5 sec

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.150	1.0	- - -	0.150	Isomeric Transition	

PH = 1.0
HPH = 1.0

ED = 0.150 Mev/D
HED = 0.150 Mev/D

Source: NDS 60-3-88 and 60-3-97

49 In $114m_1$
50 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.192	0.182	0.783(In)	0.0349	Isomeric Transition	
0.722	0.035	- - -	0.0253	and E. C.	
0.556	0.035	- - -	0.0195		
capture e^-	- - -	0.035(Cd)	- - -		
Total	0.252	0.818	0.0797		

E_K(Cd) = 0.0236 Mev $N_K E_K$ = 0.0008
E_K(In) = 0.0247 Mev $N_K E_K$ = 0.0193
PH = 1.070 ED = 0.0998 Mev/D
HPH = 1.070 HED = 0.0998 Mev/D

Source: NDS 60-3-88 and 60-3-96

49 In 114
72 sec.

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.30	0.0015	- - -	0.0020	0.670	0.002
1.21	0.0025	- - -	0.0030	1.984	0.989
- - -	- - -	- - -	- - -	0.397	0.003
capture e^-	- - -	0.01	- - -		
Total	0.0040	0.01	0.0050		

E_K = 0.0236 Mev $N_K E_K$ = 0.0002
PH = 0.0140 ED = 0.0052 Mev/D
HPH = 0.0140 HED = 0.0052 Mev/D

Source: NDS 60-2-99 and 60-2-106

50 Sn 113m
27 min.

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.079	1.0	- - -	0.079	Isomeric Transition	

PH = 1.0 ED = 0.079 Mev/D
HPH = 1.0 HED = 0.079 Mev/D

Source: NDS 60-2-99 and 60-2-106. W. E. Phillips and J. I. Hopkins, Phys. Rev. 119, 1315 (1960).

50 Sn 113
118 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.255	0.02	- - -	0.0051	Decays by E. C.	
0.393	0.68	0.32	0.2672		
capture e^-	- - -	1.00	- - -		
Total	0.70	1.32	0.3723		

E_K = 0.0247 Mev
PH = 2.02
HPH = 2.02

$N_K E_K$ = 0.0326
ED = 0.4049 Mev/D
HED = 0.4049 Mev/D

Source: NDS 60-4-66 and 60-4-70

51 Sb 120m
5.8 days

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.039	0.90	0.70	0.20	0.062	Decays by E. C.	
0.199	1.00	0.88	0.12	0.175		
1.040	1.00	1.00	- - -	1.040		
1.180	1.00	1.00	- - -	1.180		
capture e^-	- - -	- - -	1.00	- - -		
Total	3.90	3.58	1.32	2.457		

E_K = 0.0258 Mev
PH = 4.90
HPH = 4.90

$N_K E_K$ = 0.034
ED = 2.491 Mev/D
HED = 2.491 Mev/D

Source: NDS 60-4-66 and 60-4-70

51 Sb 120
16 min.

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.18	0.013	- - -	0.015	1.70	0.436
capture e^-	- - -	0.551	- - -		

E_K = 0.0258 Mev
PH = 0.56
HPH = 0.56

$N_K E_K$ = 0.014
ED = 0.029 Mev/D
HED = 0.029 Mev/D

Source: NDS 60-6-104 and -109 and -110

53 I 126
13 day

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
1.41	0.004	0.004	- -	.0056	0.385	0.06
0.747	0.040	0.040	- -	.0299	0.865	0.29
0.665	0.330	0.330	- -	.2195	1.25	0.09
0.860	0.010	0.010	- -	.0086	0.46	0.003
0.48	0.050	0.050	- -	.0240	1.129	0.010
0.386	0.340	0.330	0.01(Xe)	.1274		
capture e⁻	- - -	- - -	0.55(Te)	- -		
Total	0.774	0.764	0.56	0.4150		

E_K(Xe) = 0.0304 Mev $E_K N_K$ = .0003 Mev/D
E_K(Te) = 0.0280 Mev $E_K N_K$ = .0154 Mev/D
PH = 1.324 ED = .4307 Mev/D
HPH = 1.324 HED = .4307 Mev/D

Source: NDS 61-2-69 and -79

55 Cs 132
6.5 day

E_γ (Mev)	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.673	0.99	- -	.6663	0.6	0.012
capture e⁻		0.97(Xe)			
Total	0.99	0.97	.6663		

(Several weak gammas and possible weak negatron decay not accounted for.)

E_K = 0.0304 Mev $E_K N_K$ = 0.0295 Mev/D
PH = 1.96 ED = 0.6958 Mev/D
HPH = 1.96 HED = 0.6958 Mev/D

Source: NDS 59-1-96 and -101

59 Pr 142
19.3 hours

E_γ (Mev)	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
1.57	0.04	- -	.0628	0.58	0.04
				2.15	0.96

E_K = 0.0382 Mev $E_K N_K$ = 0.0 Mev/D
PH = 0.04 ED = 0.0628 Mev/D
HPH = 0.04 HED = 0.0628 Mev/D

Source: NDS 59-4-79

63 Eu 152m
9.30 hrs.

E_γ (Mev)	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
1.390	0.010	0.	0.014	0.210	0.000
0.963	0.090	0.	0.087	0.560	0.016
0.841	0.110	0.	0.093	1.260	0.000
0.563	0.240	0.	0.135	1.550	0.020
0.122	0.132	0.	0.016	1.870	0.740
1.320	0.010	0.	0.013		
0.975	0.005	0.	0.005		
0.344	0.026	0.	0.009		
Total	0.623	0.	0.372		

E_K = 0.044 Mev
PH = 0.623
HPH = 0.623

$N_K E_K$ = 0.
ED = 0.372 Mev/D
HED = 0.372 Mev/D

Source: NDS 59-4-77

63 Eu 152
13.00 y

E_γ (Mev)	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.344	0.252	0.008	0.087	0.220	0.020
0.411	0.020	0.000	0.008	0.360	0.027
0.778	0.120	0.000	0.093	0.710	0.120
0.692	0.002	0.	0.001	1.040	0.018
1.100	0.025	0.	0.027	1.470	0.075
1.240	0.020	0.	0.025		
0.122	0.387	0.232	0.047		
0.245	0.075	0.005	0.018		
1.085	0.120	0.000	0.130		
0.964	0.150	0.000	0.144		
0.866	0.040	0.000	0.034		
1.112	0.130	0.000	0.144		
0.443	0.050	0.000	0.022		
1.411	0.250	0.000	0.352		
1.210	0.020	0.	0.024		
Total	1.661	0.245	1.156		

E_K = 0.044 Mev
PH = 1.906
HPH = 1.906

$N_K E_K$ = 0.011
ED = 1.167 Mev/D
HED = 1.167 Mev/D

Source: NDS 5-5-27 and -39

64 Gd 153
242 days

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.0697	0.160	0.037	0.123	0.0026	Decays by E.C.	
0.1032	0.560	0.224	0.336	0.0231		
0.0895	0.004	0.002	0.002	0.0002		
0.0198	0.004	0.001	- - -	- - -		
0.0974	0.380	0.280	0.090	0.0273		
0.0141	0.003	- - -	- - -	- - -		
0.0834	0.011	0.007	0.004	0.0006		
capture e⁻	- - -		1.000	- - -		
Total	1.122	0.551	1.555	0.0538		

E_K = .0425 Mev $N_K E_K$ = 0.0661 Mev/D

PH = 2.106 ED = .1199 Mev/D
HPH 2.106 HED = .1199 Mev/D

Source: NDS 5-6-108 and -116

65 Tb 158
150 years

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.2181	0.01	0.01	- -	0.0022	0.628	0.01
0.0990	0.14	0.04	0.10 (Dy)	0.0040	0.845	0.13
0.9630	0.24	0.24	- - -	0.2311		
0.7770	0.14	0.14	- - -	0.1088		
0.9450	0.41	0.41	- - -	0.3875		
0.1820	0.17	0.13	0.04 (Gd)	0.0237		
0.0795	0.86	0.12	0.74 (Gd)	0.0095		
capture e⁻	- - -	- - -	0.86 (Gd)	- - -		
Total	1.97	1.09	1.74	0.7668		

E_K(Dg) = 0.0470 Mev $N_K E_K$ = 0.0047 mev/D
E_K(Gd) = 0.0440 Mev $N_K E_K$ = 0.0722 mev/D
PH = 2.83 ED = 0.8437 Mev/D
HPH = 2.83 HED = 0.8437 Mev/D

Source NDS 5-5-81 and -88

66 Dy 159
144 day

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.0580	0.260	0.034	0.226	0.0020	Decays by E. C.	
capture e^-	- - -	- - -	1.00			
Total	0.260	0.034	1.226	0.0020		

E_K = 0.0455 Mev

$N_K E_K$ = 0.0558 Mev/D

PH = 1.260

ED = 0.0578 Mev/D

HPH = 1.260

HED = 0.0578 Mev/D

Source: NDS 6-4-36

67 Ho 166m
1200 years

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.751	0.144	0.144	- -	.1081	0.01	0.15
0.610	0.025	0.025	- -	.0153	0.06	0.85
0.451	0.027	0.027	- -	.0122		
1.242	0.010	0.010	- -	.0124		
0.711	0.580	0.580	- -	.4124		
0.569	0.071	0.071	- -	.0404		
0.410	0.130	0.130	- -	.0533		
0.830	0.106	0.106	- -	.0880		
0.465	0.017	0.017	- -	.0079		
0.300	0.037	0.037	- -	.0111		
0.950	0.033	0.033	- -	.0314		
0.670	0.057	0.057	- -	.0382		
0.258	0.010	0.010	- -	.0026		
0.810	0.600	0.600	- -	.4860		
0.529	0.100	0.100	- -	.0529		
0.2153	0.045	0.045	- -	.0097		
0.6917	0.014	0.014	- -	.0097		
0.365	0.017	0.017	- -	.0062		
0.7796	0.037	0.037	- -	.0288		
0.2[illegible]	0.310	0.292	0.018	.0818		
0.1843	0.980	0.742	0.148	.1368		
0.0806	1.000	0.125	0.209	.0101		
Total	4.350	3.219	0.375	1.6553		

(Conversion data is missing on many of these gammas. Some N_γ values may be overestimated.)

E_K = 0.0502 Mev

$N_K E_K$ = 0.0188 Mev/D

PH = 3.594

HPH = 3.594

ED = 1.6721 Mev/D

HED = 1.6721 Mev/D

Source: NDS 6-4-36 and -44 and -45

67 Ho 166
27 hours

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
1.380	0.009	0.009	- -	0.0124	0.02	0.0004
0.0806	0.480	0.060	0.102	0.0048	0.23	0.0030
Total	0.489	0.069	0.102	0.0172	0.40	0.0100
(Many very weak gamma transitions not accounted for.)					1.76	0.4760
					1.847	0.5160

E_K = 0.0502 Mev $N_K E_K$ = 0.0051 Mev/D

PH = 0.171 ED = 0.0223 Mev/D

HPH = 0.171 HED= 0.0223 Mev/D

Source: NDS 6-1-56, 6-1-57 and 6-1-64

68 Er 169
9.3 days

E_γ Mev	N_γ	N_M	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.0084	- - -	0.42	- - -	0.332	0.42
- - -	- - -	- - -	- - -	0.340	0.58

E_M = 0.00231 $N_M E_M$ = 0.001
PH = 0.42 ED = 0.001 Mev/D
HPH = 0 HED = 0 Mev/D

Source: NDS 6-4-102 and 6-4-107

68 Er 171
7.5 hours

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.9060	0.0100	0.0100	- - -	0.009	0.493	0.005
0.7960	0.0090	0.0090	- - -	0.007	0.528	0.005
0.2770	0.0085	0.0085	- - -	0.002	0.575	0.038
0.2110	0.0090	0.0090	- - -	0.002	0.753	0.004
0.1664	0.0080	0.0080	- - -	0.001	0.816	0.004
0.3083	0.7200	0.7060	0.014	0.218	1.065	0.910
0.2958	0.2900	0.2840	0.006	0.084	1.370	0.015
0.1240	0.2060	0.0940	0.056	0.012	1.490	0.021
0.1167	0.0580	0.0310	0.027	0.004		
0.1116	0.6500	0.3000	0.350	0.033		
Total	1.969	1.460	0.453	0.372		

(many less than 0.01 ignored)

E_K = 0.0519 Mev $N_K E_K$ = 0.0235
PH = 1.969 ED = 0.396 Mev/D
HPH = 1.969 HED = 0.396 Mev/D

Source NDS 6-4-70 and -78, -79, -80

69 Tm 168
86 days

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
1.464	0.005	0.005	- -	.0073	Decays by E.C.	
1.280	0.040	0.040	- -	.0512		
0.721	0.180	0.180	- -	.1298		
0.646	0.020	0.020	- -	.0129		
0.547	0.030	0.030	- -	.0164		
0.448	0.290	0.279	0.011	.1250		
1.016	0.020	0.020	- -	.0203		
0.831	0.090	0.090	- -	.0748		
0.273	0.030	0.030	- -	.0082		
0.198	0.530	0.507	0.023	.1004		
0.0993	0.040	0.040	- -	.0040		
0.917	0.050	0.050	- -	.0459		
0.732	0.050	0.050	- -	.0366		
0.817	0.540	0.540	- -	.4412		
0.632	0.140	0.140	- -	.0885		
0.822	0.140	0.140	- -	.1151		
0.743	0.110	0.110	- -	.0817		
0.285	0.012	0.012	- -	.0034		
0.184	0.210	0.175	0.035	.0322		
0.0798	0.860	0.129	0.191	.0103		
capture e^-	- - -	- - -	1.000			
Total	.3387	2.587	1.260	1.4052		

E_K = 0.0502 Mev
$M_K E_K$ = .0633 Mev/D
PH = 3.847
HPH = 3.847

ED = 1.4685 Mev/D
HED = 1.4685 Mev/D

Source: NDS 6-4-87 and 6-4-91

69 Tm 170
127 days

E_γ Mev	N_γ	N_K	N_L	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.0843	0.039	0.054	0.149	0.003	0.882	0.24
- - -	- - -	- - -	- - -	- - -	0.967	0.76

E_K = 0.0536 Mev
E_L = 0.010 Mev
PH = 0.242
HPH = 0.093
$N_K E_K$ = 0.003
$N_L E_L$ = 0.001
ED = 0.007 Mev/D
HED = 0.006 Mev/D

Source: NDS 6-4-103 and 6-4-111

69 Tm 171
1.9 years

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.06673	- - -	0.02	- - -	0.0300	0.02
- - -	- - -	- - -	- - -	0.0965	0.98

E_K = 0.0536
PH = 0.02
HPH = 0.02
$N_K E_K$ = 0.001
ED = 0.001 Mev/D
HED = 0.001 Mev/D

Source: NDS 59-2-95 nd 59-2-98. [illegible] Fossan and B. Herskind, Nucl. Phys. 40, 24 (1963)

71 Lu 176m
3.7 hours

E_γ Mev	N_T	N_γ	I_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.0883	1.00	0.088	0.91	0.0078	1.1	1.0

E_K = 0.0571 Mev

PH = 1.0
HPH = 1.0

$N_K E_K$ = 0.0521
ED = 0.0599 Mev/D
HED = 0.0599 Mev/D

Source: NDS 59-3-99. H. I. [illegible]est, Jr., L. G. Mann and R. J. Nagle, Phys. Rev. 124, 527 (1961)

71 Lu 177
6.75 days

E_γ Mev	N_T	N_γ	I_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.2084	0.121	0.121	- - -	0.0252	0.175	0.123
0.1130	0.239	0.075	0.059	0.0085	0.246	0.003
0.2497	0.002	0.002	- - -	0.0050	0.383	0.119
0.3213	0.002	0.002	- - -	0.0060	0.496	0.755
Total	0.364	0.200	0.059	0.0348		

E_K = 0.0571 Mev

PH = 0.259
HPH = 0.259

$N_K E_K$ = .0034

ED = 0.0382 Mev/D
HED = 0.0382 Mev/D

Source: J. Valentin, D. J. Horen and J. M. Hollander, Nucl. Phys. 31, 353 (1962).

72 Hf 173
24 hours

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.0778	0.001	0.001	- - -	0.0001	Decays by E. C.	
0.1236	0.985	0.835	0.150	0.1032		
0.1349	0.112	0.064	0.048	0.0086		
0.1396	0.297	0.114	0.183	0.0159		
0.1618	0.059	0.054	0.005	0.0087		
0.2967	0.372	0.366	0.006	0.1086		
0.3064	0.058	0.058	- - -	0.0178		
0.3111	0.096	0.096	- - -	0.0299		
0.3568	0.005	0.005	- - -	0.0018		
0.4223	0.005	0.005	- - -	0.0021		
0.8977	0.019	0.019	- - -	0.0171		
capture e^-	- - -	- - -	1.000	- - -		
Total	2.009	1.617	1.392	0.3138		

E_K = 0.0553 Mev
PH = 2.009
HPH = 2.009

$N_K E_K$ = 0.0770
ED = 0.3908 Mev/D
HED = 0.3908 Mev/D

(Several very weak γ's ignored.)

Source: NDS 59-2-89 and 59-2-92

72 Hf 173
70 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.08936	0.031	0.068	0.0028	Decays by E. C.	
0.11381	0.003	0.006	0.0003		
0.22960	0.006	0.001	0.0014		
0.34340	0.769	0.081	0.2641		
0.43300	0.012	- - -	0.0052		
capture e^-	- - -	1.000	- - -		
Total	0.821	1.156	0.2738		

E_K = 0.0553 Mev
PH = 1.977
HPH = 1.977

$N_K E_K$ = 0.0639
ED = 0.3377 Mev/D
HED = 0.3377 Mev/D

72 Hf 180m
5.5 hours

Source: NDS 60-1-117 and 60-1-119

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
0.501	0.166	0.004	0.0832
0.058	0.624	- - -	0.0362
0.444	0.809	0.021	0.3592
0.332	0.948	0.052	0.3147
0.216	0.870	0.130	0.1879
0.093	0.200	0.260	0.0186
Total	3.617	0.467	0.9998

E_K = 0.0571 Mev
PH = 4.084
HPH = 4.084

$E_K N_K$ = 0.0267
ED = 1.027 Mev/D
HED = 1.027 Mev/D

E_β Mev	N_β
Isomeric Transition	

Source: NDS 60-2-110

72 Hf 181
45 day

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.3476	0.001	- - -	0.0003	0.065	0.003
0.3423	0.001	- - -	0.0003	0.340	0.010
0.2590	0.002	- - -	0.0005	0.404	0.040
0.6990	0.010	- - -	0.0070	0.408	0.920
0.2170	0.005	- - -	0.0011	0.550	0.020
0.6190	0.0004	- - -	0.0002		
0.1369	0.041	- - -	0.0056		
0.6155	0.003	- - -	0.0018		
0.1330	0.650	0.210	0.0865		
0.4820	0.800	0.019	0.3856		
0.4760	0.020	- - -	0.0095		
0.3458	0.140	- - -	0.0484		
0.1361	0.050	0.100	0.0068		
0.0063	0.020	- - -	0.0001		
Total	1.743	0.329	0.5537		

E_K = 0.0571 Mev $N_K E_K$ = 0.0188
PH = 2.072 ED = 0.5725 Mev/D
HPH = 2.072 HED = 0.5725 Mev/D

Source: NDS 60-1-117 and -121, and C. J. Gallagher, Jr., M. Jørgensen and O. Skilbreid, Nucl. Phys. 33, 285 (1962).

73 Ta 180m
8.15 hour

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.102	0.007	0.006 (W)	0.0007	0.600	0.032
0.093	0.068	0.068 (Hf)	0.0063	0.705	0.098
capture e-	- - -	0.870 (Hf)	- - -		
Total	0.075	0.944	0.0070		

E_K(W) = 0.0607 Mev $N_K E_K$ = 0.0004
E_K(Hf) = 0.0571 Mev $N_K E_K$ = 0.0536
PH = 1.019 ED = 0.061 Mev/D
HPH = 1.019 HED = 0.061 Mev/D

Source: NDS 60-1-126 ard -132

73 Ta 182m
16 min

E_γ	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.356	0.042	0.008	0.034	0.0028	Isomeric	
0.184	0.958	0.551	0.407	0.1014	transition	
0.319	0.074	0.067	0.007	0.0214		
0.172	0.884	0.505	0.379	0.0869		
0.147	0.926	0.463	0.463	0.0681		
Total	2.884	1.594	1.290	0.2806		

E_K = 0.0589 Mev $N_K E_K$ = 0.0760

PH = 2.884 ED = 0.3566 Mev/D

HPH = 2.884 HED = 0.3566 Mev/D

Source: NDS 60-1-126 and 60-1-137

73 Ta 182
115 days

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.264	0.0800	0.074	0.006	0.0195	0.180	0.38
0.220	0.1300	0.130	- - -	0.0286	0.250	0.05
0.179	0.0700	0.055	0.015	0.0098	0.330	0.02
0.066	0.1000	0.026	- - -	0.0017	0.363	0.20
0.198	0.0400	0.034	0.006	0.0067	0.443	0.23
0.156	0.0400	0.040	- - -	0.0062	0.480	0.04
0.114	0.0600	0.020	0.040	0.0023	0.514	0.08
0.116	0.0200	0.020	- - -	0.0023		
1.375	0.0040	0.004	- - -	0.0055		
1.273	0.0019	0.002	- - -	0.0025		
0.152	0.0090	0.006	0.003	0.0009		
0.085	0.1400	0.042	- - -	0.0036		
1.231	0.1100	0.110	- - -	0.1354		
1.003	0.0300	0.030	- - -	0.0301		
1.289	0.0160	0.016	- - -	0.0206		
1.189	0.1500	0.004	0.146	0.0048		
0.960	0.0080	0.008	- - -	0.0077		
0.0677	0.3400	0.266	- - -	0.0180		
1.254	0.0200	0.020	- - -	0.0251		
1.155	0.0100	- - -	0.010	- - -		
0.927	0.0090	0.009	- - -	0.0083		
1.222	0.2800	0.013	0.267	0.0159		
1.122	0.3300	0.010	0.320	0.0112		
0.229	0.0800	0.070	0.010	0.0160		
0.100	0.5600	0.280	0.280	0.0280		
Total	2.6380	1.289	1.103	0.4107		

E_K = 0.0607 Mev
PH = 2.392
HPH = 2.392

$N_K E_K$ = 0.0670
ED = 0.4777 Mev/D
HED = 0.4777 Mev/D

Source: A. H. Muir, Jr., and F. Boehm, Phys. Rev. 122, 1564 (1961) 74 W 181
145 Day

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.1525	0.0011	0.0005	0.0006	0.0001	Decays by	
0.13625	0.0007	0.0003	0.0004	- - -	E.C.	
0.00625	0.3500	- - - -	- - -	- - -		
capture e⁻	- - -	- - -	1.0000	- - -		
Total	0.3518	0.0008	1.0010	0.0001		

E_K = 0.0589 Mev $N_K E_K$ = 0.0590
PH = 1.0018 ED = 0.0591 Mev/D
HPH = 1.0018 HED = 0.0591 Mev/D

Source: K. Maak Bisgard, K. Olesen and P. Østergard, Nucl. Phys. 33, 126 (1962). 74 W 187
24 hour

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.072	0.1470	0.1540	0.0106	0.325	0.08
0.107	0.0005	0.0014	0.0001	0.625	0.74
0.114	0.0011	0.0031	0.0003	1.329	0.18
0.134	0.1190	0.2120	0.0159		
0.206	0.0015	0.0046	0.0003		
0.239	0.0010	0.0004	0.0002		
0.246	0.0016	0.0005	0.0004		
0.479	0.3039	0.0061	0.1456		
0.511	0.0079	0.0002	0.0040		
0.552	0.0639	0.0004	0.0353		
0.618	0.0785	0.0025	0.0485		
0.625	0.0130	- - -	0.0081		
0.686	0.3526	0.0014	0.2419		
0.773	0.0492	0.0008	0.0380		
0.867	0.0047	0.0001	0.0041		
Total	1.1454	0.3874	0.5531		

E_K = 0.0626 Mev $N_K E_K$ = 0.0243
PH = 1.533 ED = 0.5774 Mev/D
HPH = 1.533 HED = 0.5774 Mev/D

Source: K. M. Bisgard, C. S. Cook, P. Horskøj and A. B. Knutsen, Nucl. Phys. 41, 32 (1963), and NDS 60-1-142 and -148.

75 Re 184
50 days

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.330	0.003	0.003	- - -	0.0010	Decays by	
0.230	0.004	0.004	- - -	0.0009	E.C.	
0.250	0.008	0.008	- - -	0.0020		
0.895	0.190	0.190	- - -	0.1701		
0.642	0.005	0.005	- - -	0.0032		
0.904	0.400	0.400	- - -	0.3616		
0.793	0.400	0.396	0.004	0.3140		
0.540	0.006	0.006	- - -	0.0032		
0.253	0.042	0.037	0.005	0.0094		
0.111	0.600	0.151	0.151	0.0168		
capture e^-	- - -	- - -	1.000	- - -		
Total	1.658	1.200	1.160	0.8822		

E_K = 0.0607
PH = 2.360
HPH = 2.360

$N_K E_K$ = 0.0704
ED = 0.9526 Mev/D
HED = 0.9526 Mev/D

Source: NDS 59-5-132 and -134

75 Re 186
90 hours

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.122	0.0383	0.0343	0.0040 (W)	0.0042	0.34	0.069
0.768	0.0003	0.0003	- - -	0.0002	0.934	0.231
0.631	0.0004	0.0004	- - -	0.0003	1.071	0.73
0.137	1.0000	0.4348	0.1739 (Os)	0.0596		
capture e^-	- - -	- - -	0.0383 (W)	- - -		
Total	1.0390	0.4698	0.2162	0.0643		

E_K(W) = 0.0607 Mev
E_K(Os) = 0.0645 Mev

$N_K E_K$ = 0.0026
$N_K E_K$ = 0.0112

PH = 0.686
HPH = 0.686

ED = 0.0781 Mev/D
HED = 0.0781 Mev/D

Source: R. Hardell and S. Nilsson
Nucl. Phys. 39, 286 (1962)

75 Re 188m
18.7 min

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.064	0.333	0.667	0.0213	Isomeric Transition	

E_K = 0.0626 Mev
PH = 1.0
HPH = 1.0

$N_K E_K$ = 0.0418
ED = 0.0631 Mev/D
HED = 0.0631 Mev/D

Source: NDS 59-3-119 and 59-3-123

75 Re 188
17 hour

E_γ Mev	N_γ	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.155	0.200	0.116	0.084	0.0180	0.16	0.0004
0.478	0.010	0.010	- - -	0.0048	0.18	0.0004
0.633	0.015	0.015	- - -	0.0095	0.35	0.0010
0.828	0.005	0.005	- - -	0.0041	0.66	0.0040
0.931	0.006	0.006	- - -	0.0056	0.81	0.0010
Total	0.236	0.152	0.084	0.0420	1.03	0.0040
					1.48	0.0100
					1.96	0.2000
					2.116	0.7800

E_K = 0.0645 Mev
PH = 0.236
HPH = 0.236

$N_K E_K$ = 0.0054
ED = 0.0474 Mev/D
HED = 0.0474 Mev/D

Source: NDS 5-3-3 and 5-3-7

76 Os 190m
10 min.

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.0384	1.00	- - -	1.00	- - -	Isomeric	
0.1870	0.88	0.74	0.14	0.1384	Transition	
0.3610	0.92	0.88	0.04	0.3177		
0.5000	1.00	0.98	0.02	0.4900		
0.6140	0.91	0.90	0.01	0.5526		
Total	4.71	3.50	1.21	1.4987		

E_K = 0.0645 Mev
PH = 4.71
HPH = 4.71

$N_K E_K$ = 0.0780
ED = 1.577 Mev/D
HED = 1.577 Mev/D

Source: NDS 5-3-17

76 Os 191
15 days

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
(1867	0.001	0.001	- - -	.0002	0.123	0.001
0.042	0.999	- - -	- - -	- - -	0.139	0.999
0.1294	0.999	0.250	0.749	.0324		
0.047	- - -	- - -	- - -	- - -		
0.0823	- - -	- - -	- - -	- - -		
Total	1.999	0.251	0.749	.0326		

E_K = 0.0645 Mev
PH = 1.000
HPH = 1.000

$N_K E_K$ = .0483 Mev/D
ED = .0809 Mev/D
HED = .0809 Mev/D

Source: NDS 61-3-97

76 Os 193
32 hours

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.299	0.004	0.004	- -	.0012	0.52	0.008
0.251	0.004	0.003	0.001	.0008	0.57	0.032
0.559	0.022	0.021	0.001	.0117	0.67	0.074
0.468	0.003	0.003	- -	.0014	0.77	0.004
0.460	0.041	0.038	0.003	.0175	0.82	0.004
0.278	0.006	0.006	- -	.0017	0.85	0.010
0.196	0.001	0.001	- -	.0002	0.88	0.013
0.388	0.016	0.014	0.001	.0054	0.99	0.087
0.322	0.017	0.016	0.001	.0052	1.059	0.064
0.362	0.006	0.005	- -	.0018	1.132	0.700
0.289	0.003	0.003	- -	.0009		
0.314	0.003	0.003	- -	.0009		
0.243	0.002	0.002	- -	.0005		
0.117	0.003	0.002	0.001	.0004		
0.281	0.016	0.013	0.003	.0037		
0.248	0.003	0.003	- -	.0007		
0.107	0.010	0.003	- -	.0003		
0.139	0.012	0.005	0.006	.0007		
0.073	0.085	- -	- -	- -		
Total	0.257	0.145	0.017	.0550		

E_K = 0.0645 Mev

$N_K E_K$ = 0.0011 Mev/D

PH = .162

ED = 0.0561 Mev/D

HPH = .162

HED = 0.0561 Mev/D

Source: NDS 5-3-3 and 5-3-11

77 Ir 190m
3.2 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
capture e^-	- - -	0 88	- - -	2.04	0.12
				Decay is to 10 min. 76 0s 190m, q.v.	
E_K = 0.0645 Mev		$N_K E_K$ = 0.0568			
PH = 0.88		ED = 0.0568 Mev/D			
HPH = 0.88		HED = 0.0568 Mev/D			

Source: NDS 5-3-3 and 5-3-9

77 Ir 190
12 days

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.330	0.005	0.005	- - -	0.0067	Decays by E. C.	
0.197	0.070	0.050	0.020	0.0099		
0.725	0.039	0.039	- - -	0.0283		
0.518	0.270	0.270	- - -	0.1399		
0.295	0.082	0.082	- - -	0.0242		
1.020	0.028	0.028	- - -	0.0286		
0.827	0.040	0.040	- - -	0.0331		
0.224	0.052	0.052	- - -	0.0116		
0.604	0.320	0.317	0.003	0.1915		
0.407	0.270	0.263	0.007	0.1070		
0.206	0.040	0.040	- - -	0.0082		
0.767	0.020	0.020	- - -	0.0153		
0.397	0.056	0.056	- - -	0.0222		
0.199	0.010	0.007	0.003	0.0014		
0.569	0.250	0.247	0.003	0.1405		
0.198	0.030	0.021	0.009	0.0042		
0.557	0.280	0.276	0.004	0.1537		
0.371	0.230	0.222	0.008	0.0824		
0.361	0.150	0.144	0.006	0.0520		
0.187	0.720	0.576	0.144	0.1077		
capture e^-	- - -	- - -	1.000	- - -		
Total	2.962	2.755	1.207	1.1684		

E_K = 0.0645 Mev
PH = 3.962
HPH = 3.962

$N_K E_K$ = 0.0779
ED = 1.246 Mev/D
HED = 1.246 Mev/D

Source: NDS 5-3-33 and 5-3-44

77 Ir $192m_2$
650 year

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
0.161	1.0	0.08	0.92	0.0129

E_β Mev	N_β
Isomeric Transition	

E_K = 0.0664 Mev $N_K E_K$ = 0.0611
PH = 1.0 ED = 0.0740 Mev/D
HPH = 1.0 HED = 0.0740 Mev/D

SOURCE: NDS 5-3-33 and 5-3-37 to 41

77 Ir 192
74 day

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
0.4847	0.030	0.029	0.001^{Os}	0.0141
0.2013	0.007	0.006	0.001^{Os}	0.0012
0.3744	0.006	0.006	- - -	0.0022
0.4891	0.004	0.004	- - -	0.0020
0.2834	0.004	0.004	- - -	0.0011
0.2057	0.038	0.038	- - -	0.0078
0.885	0.004	0.004	- - -	0.0035
0.5886	0.048	0.047	0.001^{Pt}	0.0277
0.417	0.014	0.014	- - -	0.0058
0.282	0.010	0.010	- - -	0.0028
0.6044	0.093	0.091	0.002^{Pt}	0.0550
0.3084	0.030	0.028	0.002^{Pt}	0.0086
0.1363	0.018	0.018	- - -	0.0025
0.4680	0.480	0.471	0.009^{Pt}	0.2204
0.173	0.012	0.012	- - -	0.0021
0.6124	0.063	0.062	0.001^{Pt}	0.0380
0.2959	0.290	0.282	0.008^{Pt}	0.0834
0.3165	0.800	0.759	0.041^{Pt}	0.2402
capture e⁻	- - -	- - -	0.043^{Os}	- - -
Total	1.951	1.885	0.109	0.7184

E_β Mev	N_β
.072	.0008
.095	.0012
.24	.076
.535	.42
.669	.46

E_K(Os) = 0.0645 Mev $N_K E_K$ = 0.0029
E_K(Pt) = 0.0684 Mev $N_K E_K$ = 0.0044
PH = 1.994 ED = 0.7257 Mev/D
HPH = 1.994 HED = 0.7257 Mev/D

Source: NDS 61-3-97 and 61-3-103

77 Ir 193m
12 days

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.0802	1.0	1.0	- -	0.0802	Isomeric Transition	

PH = 1.0 ED = 0.0802 Mev/D
HPH = 1.0 HED = 0.0802 Mev/D

Source: NDS 61-4-65 and 61-4-70 and -71

77 Ir 194
19 hours

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.293	0.069	0.065	0.004	0.0190	0.438	0.0115
0.3285	0.330	0.330	- - -	0.1084	0.725	0.0107
0.6453	0.027	0.027	- - -	0.0174	0.756	0.0166
0.9389	0.015	0.015	- - -	0.0141	0.969	0.0416
1.1513	0.016	0.016	- - -	0.0184	1.614	0.0306
Total	0.457	0.453	0.004	0.1773	1.908	0.2050
(Several weak gammas are not accounted for.)					2.236	0.6600
					Many others	0.01

E_K = .0684 Mev ED = .1776 Mev/D
PH = .457 HED = 1776 Mev/D
HPH .457

SOURCE: NDS 5-3-16 and 5-3-24

78 Pt 191
3 days

E_γ Mev	N_K	N_γ	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.0965	0.044	0.0220	0.0008	Decays by E. C.	
0.1294	0.044	0.0220	0.0028		
0.175	- - -	0.0255	0.0045		
0.269	- - -	0.0072	0.0019		
0.360	- - -	0.0867	0.0312		
0.410	- - -	0.0510	0.0209		
0.457	- - -	0.0193	0.0088		
0.539	- - -	0.1734	0.0935		
0.624	- - -	0.0182	0.0114		
capture	1.0	- - -	- - -		
Total	1.044	0.4120	0.1758		

(Several weak gammas and some L X-rays are not accounted for.)

E_K = 0.0664 Mev, $N_K E_K$ = 0.0693

ED = 0.2451 Mev/D
HED = 0.2451 Mev/D

PH = 1.456
HPH = 1.456

SOURCE: NDS 61-3-97 and 61-3-104

78 Pt 193m
4.4 days

E_γ Mev	N_T	N_K	N_γ	$N_\gamma E_\gamma$ Mev/D
0.1355	1.00	1.00	- -	- - -
0.0127	1.00	- -	1.00	0.0127
Total	2.00	1.00	1.00	0.0127

E_β Mev	N_β
Isomeric Transition	

E_K = 0.0684 Mev
PH = 2.00
HPH = 1.00

$N_K E_K$ = 0.0684
ED = 0.0811 Mev/D
HED = 0.0684 Mev/D

Source: NDS 61-4-92 and 61-4-98

78 Pt 195m
4.1 days

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β N_β (Mev)
0.130	1.00	0.812	0.188	0.1056	Isomeric Transition
0.0988	0.90	0.090	0.810	0.0089	
0.129	0.10	0.100	- - -	0.0129	
0.0308	0.90	0.300	- - -	0.0092	
Total	2.90	1.302	0.998	0.1366	

E_K = 0.0684 Mev $N_K E_K$ = 0.0583
PH = 2.30 ED = 0.2049 Mev/D
HPH = 2.30 HED = 0.2049 Mev/D

Source: NDS 5-1-17 and 5-1-21

78 Pt 197
20 hours

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.0773	1.00	0.227	- - -	0.0175	0.468	0.01
0.191	0.09	0.028	0.062	0.0053	0.479	0.09
0.279	0.01	0.010	- - -	0.0028	0.670	0.90
Total	1.10	0.265	0.062	0.0256		

E_K = 0.0704 Mev $N_K E_K$ = 0.0044

PH = 0.327 ED = 0.030 Mev/D

HPH = 0.327 HED = 0.030 Mev/D

Source: NDS 5-3-55 and 5-3-58

78 Pt 199m
14 sec

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.032	1.0	0.048	- - -	0.0015	Isomeric Transition	
0.393	1.0	0.920	0.080	0.3616		
Total	2.0	0.968	0.080	0.3631		

E_K = 0.0684 Mev
PH = 1.048
HPH = 1.048

$N_K E_K$ = 0.0055
ED = 0.3686 Mev/D
HED = 0.3686 Mev/D

Source: NDS 5-2-29 and 5-2-40

79 Au 196m
9.7 hr

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.1749	1.00	- -	0.32	- - -	Isomeric Transition	
0.3162	0.08	0.08	- -	0.025		
0.2885	0.07	0.07	- -	0.020		
0.1478	0.85	0.28	0.21	0.041		
0.1882	0.65	0.21	0.36	0.040		
0.1683	0.18	0.05	0.11	0.008		
0.1377	0.03	- -	0.03	- - -		
0.0505	0.01	- -	- -	- - -		
0.0307	0.09	- -	- -	- - -		
0.0199	0.20	0.13	- -	0.003		
0.0846	1.00	0.06	- -	0.005		
Total	4.18	0.88	1.03	0.142		

E_K = 0.0704 Mev
PH = 1.91
HPH = 1.78

$N_K E_K$ = 0.073
ED = 0.215 Mev
HED = 0.212 Mev

Source: NDS 5-2-28 and 5-2-37 and 38

79 Au 196
6.18 days

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.3557	0.94	0.90	0.04	0.3201	0.259	0.06
0.3330	0.27	0.26	0.01	0.0866		
0.4261	0.06	0.06	- -	0.0256		
capture e^-	- -	- -	0.94	- - -		
Total	1.27	1.22	0.99	0.4323		

(Several weak gammas not accounted for)

E_K = 0.0684 Mev $N_K E_K$ = 0.0677

PH = 2.21 ED = 0.499 Mev/D

HPH = 2.21 HED = 0.499 Mev/D

Source: NDS 5-2-48, 5-2-54 and 55

79 Au 198
2.7 days

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
1.087	0.0018	0.0018	- -	0.0020	0.287	0.01
0.675	0.0082	0.0082	- -	0.0055	0.962	0.99
0.4118	0.9982	0.9710	0.0272	0.3999		
Total	1.0082	0.9810	0.0272	0.4074		

E_K = 0.0725 Mev $N_K E_K$ = 0.0020

PH = 1.008 ED = 0.4094 Mev/D

HPH = 1.008 HED = 0.4094 Mev/D

Source: NDS 5-3-55 and 5-3-59

79 Au 199
3.15 days

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.0498	0.053	- -	- -	- - -	0.251	0.23
0.1583	0.753	0.58	0.17	0.0918	0.302	0.70
0.2082	0.177	0.10	0.08	0.0208	0.460	0.76
Total	0.983	0.68	0.25	0.1126		

E_K = 0.0725 Mev $N_K E_K$ = 0.0181

PH = 0.93 ED = 0.1307 Mev/D

HPH = 0.93 HED = 0.1307 Mev/D

Source: NDS 5-1-17 and 5-1-27

80 Hg 197m
24 hours

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.130	0.035	0.032	0.003	.0042	Isomeric Transition and E. C.	
0.279	0.035	0.023	0.012	.0064		
0.165	0.965	0.003	0.192	.0005		
0.134	0.965	0.311	0.242	.0417		
capture e^-	- - -	- - -	0.035	- - -		
Total	2.000	0.369	0.484	.0528		

E_K = 0.0725 Mev
PH = .853
HPH = .853

$N_K E_K$ = .0351 Mev/D
ED = .0879 Mev/D
HED = .0879 Mev/D

Source: NDS 5-1-17 and 5-1-26

80 Hg 197
65 hours

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.191	0.017	0.006	0.012	.0011	Decays by E. C.	
0.0773	1.000	0.233	- - -	.0180		
capture e⁻	- - -	- - -	1.000			
Total	1.017	0.239	1.012	.0191		

E_K = 0.0725 Mev

$N_K E_K$ = .0734 Mev/D

PH = 1.251

ED = 0.0925 Mev/D

HPH = 1.251

HED = 0.0925 Mev/D

Source: NDS 5-2-92

80 Hg 203
47 days

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.279	1.0	0.86	0.14	0.240	0.212	1.0

E_K = 0.0746 $N_K E_K$ = 0.0104
PH = 1.0 ED = 0.250 Mev/D
HPH = 1.0 HED = 0.250

Source: NDS 5-2-92 and 5-2-98

82 Pb 203
52 hours

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.680	0.008	0.008	- -	0.0054	Decays by E. C.	
0.401	0.045	0.039	0.006	0.0156		
0.279	0.990	0.853	0.137	0.2380		
capture e⁻	- - -	- - -	1.0	- - -		
Total	1.043	0.900	1.143	0.2590		

E_K = 0.0746 Mev
PH = 2.043
HPH = 2.043

$N_K E_K$ = 0.0853
ED = 0.3443 Mev/D
HED = 0.3443 Mev/D

Source: NDS 5-1-36 and 5-1-41

82 Pb 204m
67 min

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.912	1.0	0.95	0.05	0.8664	Isomeric Transition	
0.375	1.0	0.96	0.04	0.3600		
0.899	1.0	0.99	0.01	0.8900		
Total	3.0	2.90	0.10	2.1164		

E_K = 0.0767 Mev
PH = 3.0
HPH = 3.0

$N_K E_K$ = 0.0077
ED = 2.124 Mev/D
HED= 2.124 Mev/D

Source: J. O. Rasmussen, F. L. Canavan and J. M. Hollander, Phys. Rev. 107, 141 (1957). 92 U 237 6.75 days

E_γ (Mev)	N_γ	N_K	N_{L1}	N_{L2}	N_{L3}	N_M	$N_\gamma E_\gamma$	E_β (Mev)	N_β
0.060	0.360	- -	0.075	0.149	0.047	0.085	0.021	0.248	0.960
0.065	0.023	- -	0.003	0.003	0.003	- - -	0.001		
0.165	0.036	0.005	0.002	0.013	0.006	0.005	0.006		
0.208	0.240	0.620	0.108	0.014	0.001	0.022	0.050		
0.234	- - -	0.001	- - -	- - -					
0.267	- - -	0.005	0.002	- - -					
0.332	0.014	- - -	- - -				0.005		
0.335	0.002	- - -	- - -				0.001		
0.368	- - -	- - -							
0.371	- - -	- - -							
Total	0.675	0.631	0.190	0.179	0.057	0.112	0.084		

E_K = 0.103 Mev $N_K E_K$ = 0.065

E_{L1} = 0.022 Mev $N_{L1} E_{L1}$ = 0.004

E_{L2} = 0.022 Mev $N_{L2} E_{L2}$ = 0.004

E_{L3} = 0.018 Mev $N_{L3} E_{L3}$ = 0.001

E_M = 0.006 Mev $N_M E_M$ = 0.001

PH = 1.844 ED = 0.159 Mev/D

HPH = 1.675 HED = 0.157 Mev/D

Source: C. F. Miller, USNRDL-TR-160, (1957). 92 U 239 23.5 Min.

E_γ (Mev)	N_γ	N_K	N_L	$N_\gamma E_\gamma$	E_β (Mev)	N_β
0.074	0.830	- -	0.170	0.062	1.210	1.000

E_L = 0.022 $N_L E_L$ = 0.004

PH = 1.000 ED = 0.066 Mev/D

HPH = 1.000 HED = 0.066 Mev/D

Source: M. E. Bunker, et al. 92 U 240
Phys. Rev. 116, 143 (1959). 14.1 hrs.

E_γ (Mev)	N_γ	N_L	$N_\gamma E_\gamma$	E_β (Mev)	N_β
0.044	0.063	0.188	0.003	0.320	0.250

E_L = 0.022
PH = 0.251
HPH = 0.251

$N_L E_L$ = 0.004
ED = 0.007 Mev/D
HED = 0.007 Mev/D

Source: J. Borggreen, O. B. Nielsen and H. Nordby 93 Np 238
Nucl. Phys. 29, 515 (1962). 2.1 Days

E_γ (Mev)	N_γ	N_K	N_{L1+L2}	N_{L3}	N_M	N_N	$N_\gamma E_\gamma$	E_β (Mev)	N_β
0.044	- -	- -	0.145	0.106	0.175	0.036	- -	1.240	0.580
1.010	- -	- -	0.019	0.009	0.010	0.002	- -	0.260	0.420
0.885	0.009	- -	- - -				0.008		
0.925	0.025	- -	- - -				0.023		
0.986	0.241	0.003	0.001	- - -	- -	- -	0.238		
1.030	0.174	0.002	0.001	- - -	- -		0.180		
Total	0.449	0.005	0.166	0.115	0.185	0.038	0.449		

E_K = 0.106 Mev $N_K E_K$ = 0.001
$E_{L1+L2\ AVG}$ = 0.022 Mev $N_{L1+L2} E_{L1+L2}$ = 0.004
E_{L3} = 0.018 Mev $N_{L3} E_{L3}$ = 0.002
E_M = 0.006 Mev $N_M E_M$ = 0.001
E_N = 0.002 Mev $N_N E_N$ = 0.0001

PH = 0.958 ED = 0.457 Mev/D
HPH = 0.620 HED = 0.454 Mev/D

Source: C. F. Miller, USNRDL-TR-160, (1957). 93 Np 239
R. D. Connor and I. L. Fairweather, 56.0 hrs.
Pro. Phys. Soc. (London) 74, 161 (1959).

E_γ (Mev)	N_γ	N_K	N_{L+M}	$N_\gamma E_\gamma$	E_β (Mev)	N_β
0.045	0.001	- -	0.046	- -	0.713	0.065
0.049	0.001	- -	0.079	- -	0.654	0.040
0.057	0.001	- -	0.213	- -	0.437	0.480
0.061	0.059	- -	0.002	0.004	0.393	0.135
0.068	0.002	- -	0.136	- -	0.332	0.280
0.106	0.314	- -	0.072	0.033		
0.182	0.005	- -	0.001	0.001		
0.210	0.029	0.080	0.026	0.006		
0.226	0.001	0.002	- - -	- - -		
0.228	0.083	0.187	0.055	0.019		
0.255	0.022	0.002	- - -	0.006		
0.273	0.008	0.012	0.003	0.002		
0.278	0.133	0.178	0.047	0.037		
0.286	0.012	0.025	0.010	0.003		
0.316	0.004	- -	- -	0.001		
0.335	0.021	0.001	- -	0.007		
	0.696	0.487	0.690	0.119		

E_K = 0.106 Mev $N_K E_K$ = 0.052

E_L = 0.022 Mev $N_L E_L$ = 0.015

PH = 1.873 ED = 0.186 Mev/D

HPH = 1.873 HED = 0.186 Mev/D

Source: M. E. Bunker, B. J. Dropesky, J. D. Knight J. W. Starner and B. Warren, Phys. Rev. 116, 143 (1959).

93 Np 240
7.3 Min.

E_γ (Mev)	N_γ	N_K	$E_\gamma N_\gamma$
0.260	0.019	0.001	0.005
0.304	0.009	- - -	0.003
0.554	0.214	0.002	0.119
0.597	0.126	0.001	0.075
0.758	0.013	- - -	0.010
0.816	0.016	- - -	0.013
0.820	0.003	- - -	0.002
0.898	0.012	- - -	0.011
0.936	0.003	- - -	0.003
0.942	0.019	- - -	0.018
1.490	0.015	- - -	0.022
1.530	0.019	- - -	0.029
1.620	0.007	- - -	0.011
Total	0.475	0.004	0.321

E_β (Mev)	N_β
2.180	0.520
1.600	0.310
1.300	0.100
0.650	0.070

E_K = 0.479 Mev

$N_K E_K$ = 0.0004

PH = 0.479

ED = 0.321

HPH = 0.479

HED = 0.321

Source: F. Asaro and I. Perlman, Phys. Rev. 94, 381 (1954), and D. C. Hoffman, G. P. Ford and F. O. Lawrence, J. Inorg. Nucl. Chem. 5, 6 (1957).

94 Pu 238
86.4 years

E_γ (Mev)	N_γ	N_K	N_L	$N_\gamma E_\gamma$
0.099	0.0001	- -	0.0008	- -
0.0438	0.0004	- -	0.2796	- -
Total	0.0005		0.2804	

(Very weak 0.150 Mev gamma observed.)

E_L = 0.017 Mev

$N_L E_{I,}$ = 0.0048

PH = 0.2809

ED = 0.0048

HPH = 0.0005

HED 0

E_α (Mev)	N_α
Alpha decay	
5.352	0.0009
5.452	0.28
5.495	0.72

APPENDIX II

EXPOSURE-RATE MULTIPLIERS

The following list gives an exposure-rate multiplier for each nuclide contained in Appendix I. The point of exposure is assumed to be 3 feet above an infinite plane uniformly contaminated with the nuclide in question. The units of the multiplier are roentgens-sec-cm^2-hr^{-1}-$disintegrations^{-1}$. The multiplier will convert nuclide activities in $disintegrations\text{-}sec^{-1}\text{-}cm^{-2}$ to exposure rates in $roentgens\text{-}hr^{-1}$. The figure in parentheses indicates the number of zeros between the decimal point and the first significant figure; i.e., (6)297 is to be read 0.000000297 or 0.297×10^{-6}.

Nuclide	Half-life	Multiplier	Nuclide	Half-life	Multiplier
Be 7	53.4 d	(6)297	Ag 108m	≥ 5 y	(5)953
Na 22	2.6 y	(5)605	Ag 108	2.4 m	(7)943
Na 24	15.0 h	(4)171	Ag 109m	39.0 s	(7)805
Al 26	7.4×10^5 y	(5)812	Ag 110m	253 d	(4)137
Si 31	2.6 h	(8)422	Ag 110	24 s	(6)175
Cl 34m	32.4 m	(5)617	Cd 107	6.5 h	(6)384
Cl 38	38 m	(5)642	Cd 109	470 d	(6)106
K 40	1.27×10^9 y	(6)737	Cd 113m	14 y	(8)140
K 42	12.5 h	(5)126	In 113m	1.7 h	(5)144
Sc 44m	2.4 d	(5)127	In $114m_2$	2.5 s	(6)798
Sc 44	3.9 h	(5)589	In $114m_1$	50 d	(6)506
Sc 46m	20 s	(6)400	In 114	72 s	(7)248
Sc 46	84 d	(4)100	Sn 113m	27 m	(6)426
Ti 45	3.1 h	(8)923	Sn 113	118 d	(5)263
*V 49	330 d	-	Sb 120m	5.8 d	(4)123
Cr 49	42 m	(6)288	Sb 120	16 m	(6)143
Cr 51	28 d	(6)160	I 126	13 d	(5)230
Mn 54	291 d	(5)431	Cs 132	6.5 d	(5)366
Mn 56	2.58 h	(5)872	Pr 142	19.3 h	(6)283
*Fe 55	2.7 y	-	Eu 152m	9.3 h	(5)192
Fe 59	45 d	(5)580	Eu 152	13.0 y	(5)580
Co 57	270 d	(6)649	Gd 153	242 d	(6)617
*Co 58m	9.0 h	(6)120	Tb 158	150 y	(5)427
Co 58	71 d	(5)426	Dy 159	144 d	(6)337
Co 60	5.27 y	(4)119	Ho 166m	1200 y	(5)874
Ni 57	36.5 h	(5)682	Ho 166	27 h	(6)110
Ni 65	2.5 h	(5)286	*Er 169	9.3 d	-
Cu 64	.3 h	(7)377	Er 171	7.5 h	(5)212
Zn 63	38.4 m	(6)508	Tm 168	86 d	(5)764
Zn 65	245 d	(5)267	Tm 170	127 d	(7)390
Zn 69m	14 h	(5)220	*Tm 171	1.9 y	(8)532
Zn 71m	4 h	(5)793	Lu 176	3.7 h	(6)333
Zn 71	2.45 m	(6)650	Lu 177	6.75 d	(6)204
As 74m	8.0 s	(5)150	Hf 173	24 h	(5)210
As 74	18 d	(5)246	Hf 175	70 d	(5)176
Y 88	105 d	(4)123	Hf 180m	5.5 h	(5)548
Rh 102	206 d	(5)299	Hf 181	45 d	(5)306
Ag 106m	8.3 d	(4)139	Ta 180m	8.15 h	(6)337
Ag 106	24 m	(5)278	Ta 182m	16 m	(5)190
Ag 107m	44 s	(6)141	Ta 182	115 d	(5)241

*All energies less than 75 Kev.

Nuclide	Half-life	Multiplier
W 181	145 d	(6)320
W 187	24 h	(5)306
Re 184	50 d	(5)488
Re 186	90 h	(6)417
*Re 188m	18.7 m	(6)319
Re 188	17 h	(6)251
Os 190m	10 m	(5)839
Os 191	15 d	(6)413
Os 193	32 h	(6)300
*Ir 190m	3.2 h	(6)281
Ir 190	12 d	(5)669
Ir 192m$_2$	650 y	(6)362
Ir 192	74 d	(5)391
Ir 193m	12 d	(6)426
Ir 194	19 h	(6)940
Pt 191	3 d	(5)133
Pt 193m	4.4 d	(6)388
Pt 195m	4.1	(5)110
Pt 197	20 h	(6)163
Pt 199m	14 s	(5)196
Au 196m	9.7 h	(5)115
Au 196	6.18 d	(5)270
Au 198	2.7 d	(5)224
Au 199	3.15 d	(6)699
Hg 197m	24 h	(6)455
Hg 197	65 h	(6)482
Hg 203	47 d	(5)134
Pb 203	52 h	(5)182
Pb 204m	67 m	(4)109
U 237	6.75 d	(6)845
*U 239	23.5 m	(6)327
U 240	14.1 h	(7)333
Np 238	2.1 d	(5)227
Np 239	56.0 h	(6)966
Np 240	7.3 m	(5)165
Pu 238	86.4 y	(7)299

*All energies less than 75 Kev.

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13. ABSTRACT

Photon energies and photon abundances have been compiled and summarized for some induced activities which may result from nuclear events. The data are presented in tabular form, including photon energies and abundances for the gamma rays, X rays, and beta particles emitted per disintegration. A list of Multipliers is also presented for converting activities of the radionuclides to infinite-plane exposure rates.

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Naval Radiological Defense Laboratory
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VOLUME II. INDUCED ACTIVITIES, by G. R. Crocker and D. T. K. Wong 13 August 1965 89 p.
4 refs. UNCLASSIFIED

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2. Dose rate
3. Induced radioactivity
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